# OVERLAPPED AND SHADOWED TREE CROWN SEGMENTATION BASED ON HSI COLOR MODEL AND WATERSHED ALGORITHM

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Dedicated, in thankful appreciation for support, encouragement and understanding to my beloved mother, my beloved father "Allah mercy", my beloved brothers and *sisters, and beloved friend.*

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# ABSTRACT

Image provides valuable information to the human and this information could be used to take an effective dissection such as information that comes from satellite sensors. Satellite images let the human have the information from the ground for very wide area. The negative side of satellite image is the resolution is still not much high. Satellite image play a vital role in many area of our live, especially agriculture, where the human can calculate the crown of the tree for very wide area in very short time. The counting of tree will not be accurate without getting good segmentation of these crowns. This work has applied segmentation algorithm to separate crown of coconut palm tree from shadow and the overlapped crown as well. The algorithm has exploited HSI color model to differentiate the color of crown from the color of shadow. The result of using this feature gives very different color for both shadow and crown. After crown detection the algorithm used morphological operation such as image filling to enhance the crown. The following step is removing noise or pixels which considered unwanted objects. Finally, the image was segmented using watershed after applying distance transform on the image. Since this research does not has ground information to measure the accuracy, the evaluation has been done manually, where the crown has counted manually and calculate the accuracy of this work which is 73%.

# ABSTRAK

Sesuatu imej berkeupayaan memberikan informasi berharga kepada manusia dan informasi ini dapat digunakan untuk mendapatkan perincian yang efektif sebagai contoh informasi yang berasal dari sensor satelit. Imej satelit membolehkan manusia mendapatkan informasi dari permukaan tanah yang sangat luas. Tetapi dari sudut negatifnya, tahap resolusi imej tersebut masih tidak tinggi. Imej satelit memainkan peranan penting dalam pelbagai bidang hidup manusia terutamanya pertanian, yang mana manusia dapat menghitung silara pokok untuk sesuatu kawasan yang sangat luas dalam waktu yang sangat singkat. Penghitungan pokok tidak akan mendapat nilai yang tepat tanpa melakukan segmentasi yang baik dari silara pokok tersebut. Kajian ini telah menerapkan algoritma segmentasi untuk memisahkan silara pokok kelapa sawit dari bayang-bayangnya dan juga silara pokok yang bertindih. Algoritma telah mengeksploitasi model warna HSI untuk membezakan warna silara pokok dari warna bayang-bayangnya. Hasil dari penggunaan ciri ini telah memberikan warna yang sangat berbeza untuk bayang-bayang dan silara pokok. Setelah pengesanan silara pokok, operasi morfologi iaitu Image Filling digunakan untuk meningkatkan imej silara pokok. Langkah berikutnya adalah menyingkirkan noise atau piksel yang dianggap sebagai objek yang tidak diingini dan diakhiri dengan segmentasi imej dengan menggunakan teknik Watershed setelah mengubah imej dengan menggunakan teknik Distance Transform. Oleh kerana ketiadaan data pokok dari tanah untuk mengukur ketepatan kajian ini, penilaian telah dilakukan secara manual yang mana silara pokok telah dikira secara manual dan ketepatan kajian ini telah mencapai nilai sehingga 73%.

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# CHAPTER 1

# INTRODUCTION

## 1.1 Introduction

Tree plantation is one of the significant resources for supporting the economy of every country. Nowadays, different types of trees are used for producing different things around us such as chemical, fuel, food, cosmetic products. Due to the huge demand on tree-based products, the number of planted trees is expected to rise, especially after discovering that tree products could replace fossil fuel as the latter is expected as well to end. The key advantage for biofuel is being a clean energy that does not affect and pollute the air as it is with fossil fuel which emits Carbone in the air.

Therefore, as trees are valuable, there have been problems of managing the vast amount of trees in forests and counting them on handers of hectares. Counting trees would be cumbersome to labors when they have to work on very wide areas. Such manual counting is time consuming, error-prone, and costing money.

The issue we are going to address now is how to employ technologies to do the task of identifying and counting palm trees, where there is an urgent need to find

a method that can delineate and count them. This kind of information should be accurate because it will be used for counting the costs and revenues.

In brief, tree delineation and counting techniques are new research areas and till now they face many problems which will be elaborated later. Manual tree counting is an expensive way to do the plantation inventory in forest areas. The technology should introduce some solutions to solve counting tree from satellite image instead of doing it manually on the ground.

## 1.2 Research Background

There have been many researches made on identifying the crown of a tree, but those made on the area of palm tree detection are few such as (Shafri *et al.*, 2011; Jusoff and Pathan, 2009; Arasato *et al.*, 2011). The available research on palm tree counting is not sufficient and did not satisfy the need for counting enormous palm trees on wide area with high accuracy. Furthermore, most papers did not focus on advanced issues in palm tree segmentation such as overlapping, shadow and shape complex.

Shafri *et al.* (2011) is the most recent research on palm tree where it mentioned that very few papers have discussed the problem of counting palm tree. The paper gave good results, however there are some vital problems which their proposed approach could not solve such as crown overlapping even though it has considered in palm tree younger than the age of 10 where the crown is very small. The other thing which should not be omitted is that their algorithm could not distinguish the shape of the palm tree and the other kinds of tree, where the shape of palm tree have a unique shape which look like a star comparing to be like other kind of trees that does not have such unique shape.

The objective in (Arasato *et al.*, 2011) were to identify palm trees over other objects/trees using videography collected using an air craft mission over the Amazon. Region growing was used as the segmenting algorithm while two classification methods were used, i.e. K-mean and visual analysis (negative contrast/ positive contrast). The segmentation process was depending on real color composition (positive contrast), but colors cannot be used for classification every time as some trees could have or carry the same level of colors and lighting can affect the color level.

There is lack of research on the palm tree delineation and counting, meanwhile there are plenty of papers on tree counting as general. The difference between palm trees and normal trees is the shape of the crown. The crown of Normal trees takes irregular shapes and sometimes round-like shapes. On the other hand palm trees take distinct star-like shapes as shown in figure 1.1.

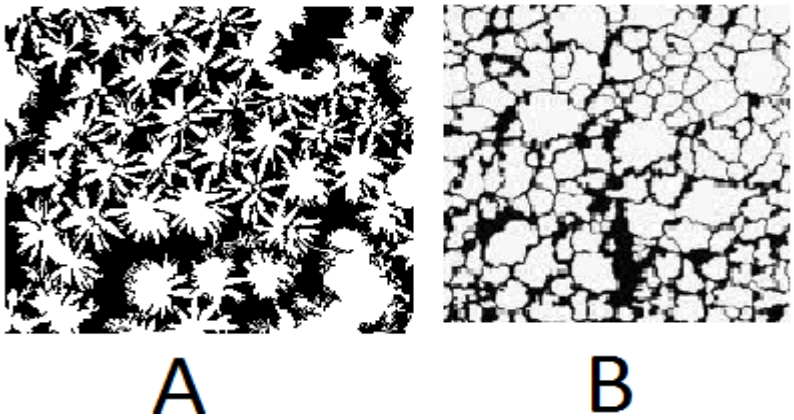


**Figure 1.1** Two crown shapes; (a) for palm tree; (b) for other type of trees

There are some of algorithms that have been implemented to segment and count trees; the following algorithms are popular in this field of research: The Valley Following Approach, Region Growing, Watershed Algorithm, Template Matching, and Marked Point Model Algorithm.

The Valley Following algorithm was developed by Gougeon where the concept of this approach considers crowns as mountains and the background as valley as in (Ke and Quackenbush, 2011; Leckie *et al.*, 2005) who employed this method. The shortcoming in this algorithm is that it cannot segment overlapped crowns and separate crowns and their shadows.

The Watershed Algorithm is a popular algorithm that has been used widely for segmenting trees, however, this method have not been used to segment palm trees according to our best knowledge. The concept of watershed is to find the area between the crown, where this algorithm deals with local maxima as local minima and vice versa. Many papers used this algorithm such as (Kwak *et al.*, 2007; Silván-Cárdenas, 2012; Kubo *et al.*, 2007) to segment and isolate crowns from the background and to avoid the over-segmentation effect. Another algorithm based on the watershed algorithm is the Marker-Controlled Watershed which was developed by Meyer and Beucher in 1990 (Ke and Quackenbush, 2011). The backward in this algorithm is that being working on greyscale image, therefore, it will not be able to differentiate a crown and its shadow.

The K-mean is used for clustering and segmenting crowns where the concept of this approach is to segment or cluster the image into k number of segments where each one is made based on the centroid point for each cluster. It was used for isolating trees in (Moreno-Garcia *et al.*, 2010) where K-where isolated crowns. K-mean algorithm is not an appropriate algorithm to solve advanced problems such as overlapped crowns and shadows due to ignoring color levels in the image.

The Region Growing Algorithm is a common algorithm which segments crowns and objects. The core principle in Region growing approach is to get the starting point or seed point and a segmentation process grows based on the neighboring pixels similar to the seed. The process will stop when some conditions become true. There are many works that used this approach such as (Arasato *et al.*, 2011; Deng *et al.*, 2010; Deng *et al.*, 2011).

This algorithm has a limitation for not distinguishing crowns and their shadows and also not overcoming overlapped crowns as it works with greyscale images, thus ignoring color levels.

The Template Matching is another approach that has not been used for crown segmentation. The idea of this approach does not rely completely on clear visible trees. Instead, it relies on matching with other images or templates; when there is a similarity between an image and the template, a matching case is announced as in (Erikson, 2004). This algorithm costs a lot because it needs some information from the ground to be matched with the sensed one.

Overall, there are few researches which work on palm tree counting and segmenting. Palm tree counting is a very new topic as all these research are recent. The tree crown detection is different from palm tree in terms of the crown's shape.

## 1.3 Problem Statement

The agriculture industry needs reliable information to control, monitor and manage forest, but the issue is that the manual or the conventional estimation of the palm tree counting cost too much in terms of time, money and labor force. Therefor there is a need for an automated or semi-automated method that can count palm trees. And in order to do so, a system needs to segment and delineate palm trees' crown first, as system cannot work without this step which is the core issue in many researches. The accuracy of counting trees relies on the method that has been used to isolate the crown and the area in the testing image. There are many problems that occur when identifying palm trees from satellite image but the most critical problems that we focus on in this research are crowns' shadows segmentation and overlapped crown segmentation. We believed that these two problems were not widely discussed in the literature reviewed in chapter 2. Thus, they are addressed here to further the research related to them.

## 1.4 Research Aim

This dissertation aims to find an automated method to segment and separate the crown of a palm tree to be used later for estimating or counting how many crowns in satellite image.

## 1.5 Research Objective

1. To develop a method for segmenting palm tree from satellite image using color information and the Watershed Algorithm.
2. To evaluate the accuracy of the proposed techniques.

## 1.6 Research Scope

- The data is satellite image with 3 bands, i.e. Red, Green and Blue.
- This research will focus on palm tree, where the palm tree grow up in many types of areas such as forest area and desert area, the data that have been used in this research have non-green background.
- The palm trees in the dataset have overlapping crowns.
- The size of the image will be varying, because it is not an issue and it can be determined automatically.
- Area testing field has the size of 25.
- Resolution of this data is 0.5 per pixel

## 1.7 Research Significance

This research is very important for monitoring and estimating the number of palm trees on the ground. This kind of research will enhance and boost the agriculture industry because it gives information on the number of trees. Stakeholders can then estimate the amount of water that will be consumed, fertilizers, and man power to do certain tasks such as harvesting.

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